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Selection of Lepidopterologically Interesting Areas in Central Spain Using UTM Distribution Maps

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Abstract. This paper deals with species richness and biogeographic interest of the butterfly fauna (*Papilionoidea* & *Hesperioidea*) of the Madrid province, using its one hundred and nine 100 sq. km UTM squares data. Richest species squares (80-102 species) are on the north (Sierra de Guadarrama) and the poorest ones on the centre and south. There is a slightly rich area on the southeast. Fauna's biogeographic interest (chorological index *sensu* Kudrna) shows a different pattern, being maximum on the southeast squares, lightly high on the south and centre, and low on the north. In conclusion, richest species squares are not necessarily those of maximum average chorological index. This is explained by the environmental similarity (climate, vegetation, etc) between Sierra and the European generality , while plant formations on the south (typically xerophytic) are peculiar in comparison with the rest of the continent, which have been used as a biogeographic reference. Consequently, species richness appears as a limited criterion when focussing the selection of areas lepidopterologically interesting. Qualitative criteria must be also considered to establish possible zones to protect their butterfly communities, such as the biogeographic interest of the fauna, provided by UTM species distribution maps.

Resumen. Este trabajo estudia el número de especies y el valor biogeográfico de la fauna de mariposas (*Papilionoidea* & *Hesperioidea*) presente en cada una de las 109 cuadrículas UTM de 100 kilómetros cuadrados de la provincia de Madrid. Las cuadrículas con mayor número de especies (entre 80 y 102) se sitúan al norte del territorio (Sierra de Guadarrama) y las más pobres en el centro y sur. Al sureste hay una zona moderadamente rica. El valor biogeográfico de la fauna (índice corológico de Kudrna) tiene un reparto bien distinto, ya que es máximo en las cuadrículas del sureste, moderadamente alto en el sur y centro, y bajo en el norte. Se infiere, por tanto, que las cuadrículas más ricas en especies no son necesariamente las de mayor índice corológico medio, lo que atribuimos a la similitud ambiental (clima, vegetación, etc) de la Sierra con la mayor parte de Europa, mientras que las formaciones vegetales del sur (encinares, coscojares y quejigares sobre todo) son más singulares (más xerófilas) con respecto al continente, ámbito de referencia biogeográfica utilizado. Concluimos con que el criterio del número de especies es de utilidad limitada en la selección de áreas de interés lepidopterológico, y que son necesarios también criterios cualitativos, como el valor biogeográfico de la fauna, para establecer zonas susceptibles de protección por su fauna de mariposas, a partir de mapas UTM de distribución de las especies.

Introduction

Decreasing numbers in many butterfly and skipper populations are awakening, among numerous naturalists, the interest for their conservation.

Obviously , the bigger the information about species the more efficient will be the measures to propose towards its conservation. Therefore, it is necessary to deep in the knowledge of some aspects such as the precise geographic distribution, environmental preferences, life cycles, interactions with foodplants, parasites and any other biological aspect affecting different species. But, in view of the fast butterfly and skipper communities impoverishment process, generally caused by different human activities, it is fairly evident that we can not wait the results of the aforementioned autoecological studies to adopt protection criteria.

Nevertheless, we believe suitable to begin applying protection measures based only on geographic range data, given that, as repeatedly has been said, ecosystem conservation, as opposed to species approach to butterfly protection, would seem to be the most effective policy to be followed (Thomas & Mallorie, 1985; Munguira, 1987; Viejo, Viedma & Martinez, 1989). And Lepidoptera atlases are very useful for those preliminary studies.

In some European countries, such as Great Britain (Heath & Skelton, 1983) or Switzerland (Gonseth, 1987), their butterfly distribution maps are already concluded, at a national scale and following UTM 100 km^2 squares system. On the opposite, in Spain we are still well behind to complete our butterfly distribution national maps, although a valuable effort on the elaboration of regional atlases within the last ten years has been made, and some of them, both from the north (Gomez de Aizpurua, 1977; 1979; 1988) as well as from central Spain (Viejo, 1983; Gomez de Aizpurua, 1987) have been already published.

Methods

The Atlas of the Lepidoptera of Madrid (Gomez de Aizpurua, 1987) provided data for this study, which compiles 153 distribution maps of species of *Zygaenoidea*, *Papilionoidea* & *Hesperioidea* in the Madrid province. We have excluded the 13 species of *Zygaenoidea*, and from the lasting 140 we have eliminated 4 because of uncertain data, as well as the records prior to 1950 with no later confirmation.

A presence-absence matrix (1-0) with the faunistic data from the one hundred and nine 100 km^2 squares of Madrid was made.From this matrix we could obtain the species number and the Average Chorological Index (Kudrna, 1986) of each square, which have been used as criteria to establish the conservation interest of the study area, given the linking relationship between butterflies and specific vegetation communities (Uherkovich, 1983; Viejo & Templado, 1986).

Species number is a variable frequently used in conservation studies (Margules & Usher 1981; Galiano, Sterling & Viejo, 1985; Usher,1986), because of its convenient obtention and handling, although it offers, by itself, just a limited information.

The chorological index proposed by Kudrna (*op. cit.*)is used here, having been

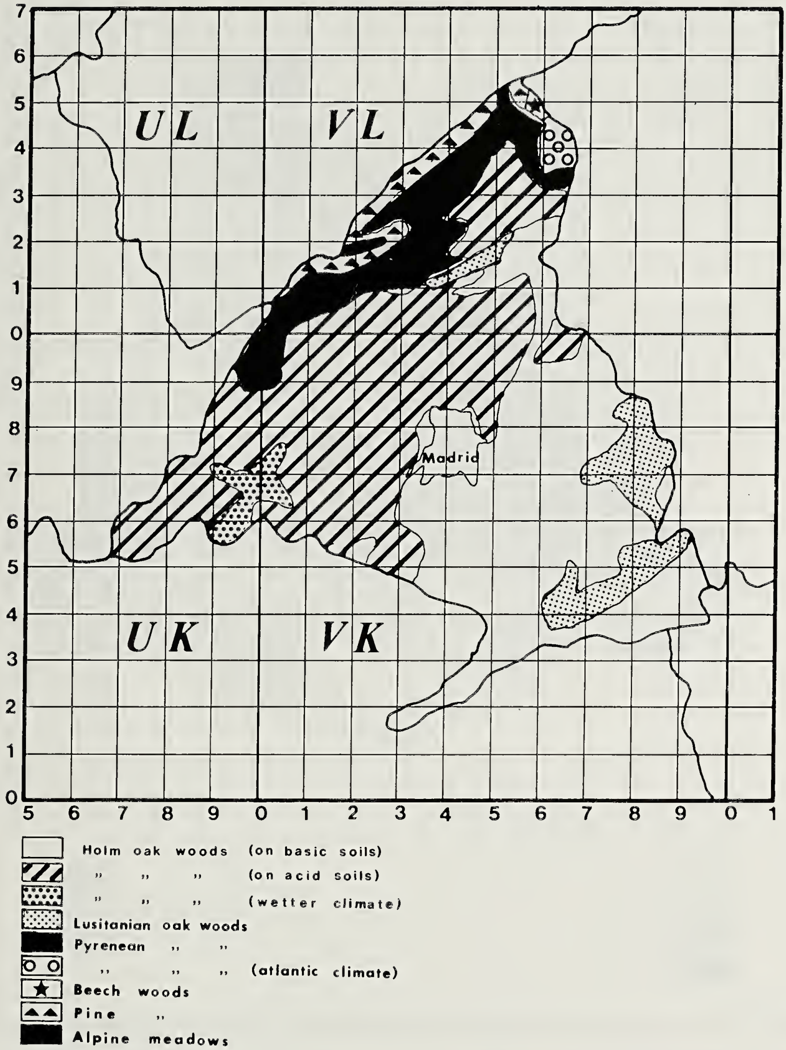

Fig. 1. Map of the climax vegetation of Madrid province (modified from Rivas Martinez, 1982).

used before by the authors in butterfly conservation studies (Sanchez & Viejo, 1988; Viejo & Viedma, 1988; Viejo, Viedma & Martinez, *op. cit.*) and it is the sum of three variables related to species range: size, composition and affinity. This index ranges from 4 to 14; high values mean biogeographically peculiar species (European endemic species with a very small range), while low values correspond to widely distributed species. The mean of the chorological index of the species occuring within a square is the square's Average Chorological Index. The higher this value, the more peculiar fauna, biogeographically speaking, in the considered square.

Data were processed with the BMDP 1D program at the Computer Center of the Universidad Autónoma de Madrid.

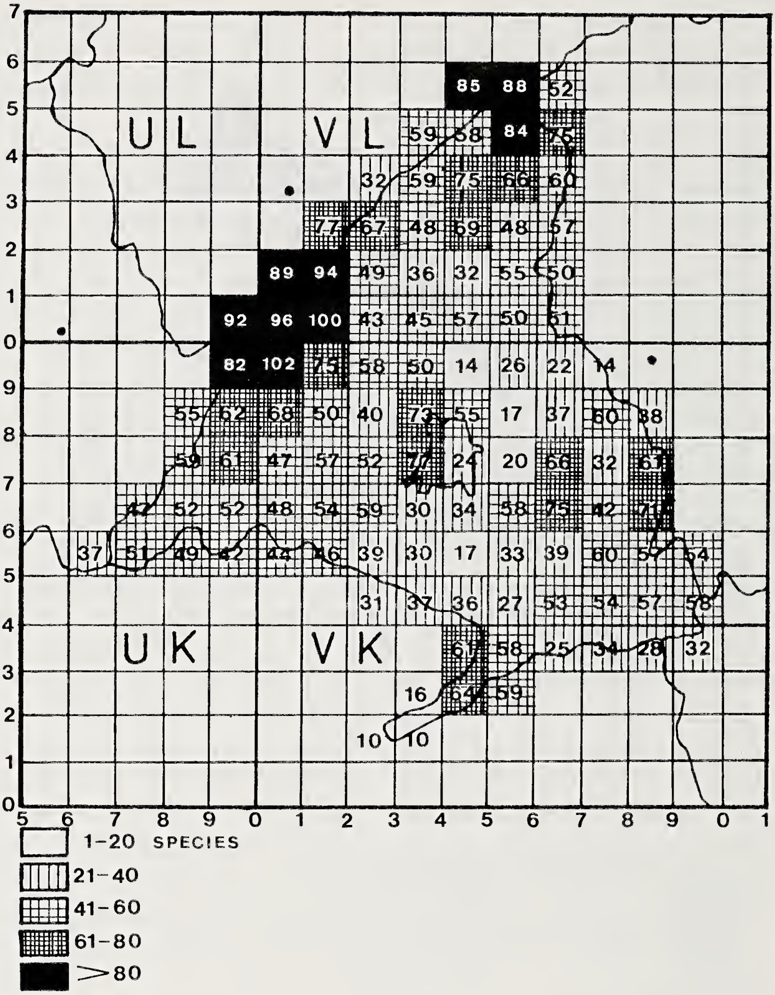

Fig. 2. Map of species richness in each 100 km² UTM grid in Madrid province.

Area of study

This paper is based on faunistic data of the Madrid province, located in the center of the Iberian Peninsula, between the 40° and 41° N parallels and the 3° and 4° W meridians. It is approximately triangle-shaped and has a surface of 8,000 km².

Geomorphologically, Madrid can be divided into two parts: the Sierra de Guadarrama (North) and the Llanos del Sur (southern Plains), according to Hernandez Pacheco (1941).

The Sierra de Guadarrama.- These mountains are included in the Sistema Central, that goes across Madrid province following the main direction of this range, that is from east-northeast to west-southwest, and runs along the north border of the province for 100 km, ranging from 1,000 m (altitude at the surrounding plain) to 2,430 m a.s.l. It is essentially constituted by archaic siliceous rocks (mainly granites and

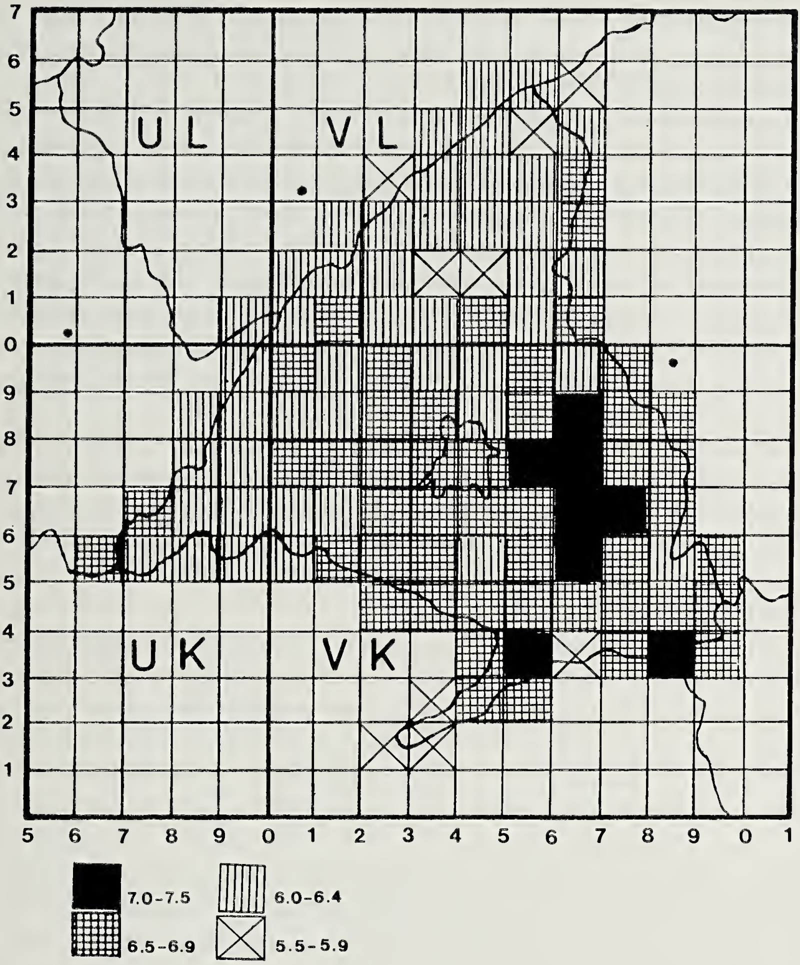

Fig. 3. Map of the Average Chorological Index values in each 100 km² UTM grid in Madrid province.

gneiss), although marly and cretaceous limy lands, miocenic arkosic sands and quaternary alluvial soils are also present. Its climate even inside the general continentality, is more humid and colder than that of the Llanos del Sur, and it is classified as Humid Mediterranean type, following to Emberger (Viejo, 1982). From a botanic point of view, the Sierra de Guadarrama belongs to the Mediterranean Region, Carpetano-Ibérico-Leonesa province (Rivas Martinez, 1982; Izco, 1984) and three bioclimatic levels can be distinguished: Supramediterranean, Oromediterranean and Crioromediterranean.

The climax vegetation of each level is respectively: Holm oak (*Quercus ilex*) and Pyrenean oak (*Q. pyrenaica*) woods, Scottish Pine (*Pinus sylvestris*) woods scattered with Juniper *Juniperus communis*) trees and high mountain alpine meadows. Cattle raising and forestry are widespread land uses in the Sierra.

Llanos del Sur.- Located at the south of the Sierra, it is a wide and flat region. Its altitude ranges from 500 to 1,000 m a.s.l. This region is lightly south-exposed, and the Tagus river traverses it along its southern border. Siliceous alluvial soils (arkosic sands) are dominant on the north and west, as well as evaporitic rocks (loams, gypsums, and pontiensic limestone)are on the south and east. Its climate can be classified between Temperate Mediterranean and Semiarid Mediterranean (Viejo, 1982), being much dryer and warmer than that of the Sierra, increasing in this tendency while going further south. This climate, the substratum and the vegetation establish a transition zone in the meeting region with the Sierra, sharing at this point some features with it. Llanos del sur are included in the Mediterranean Region, Carpetano-Ibérico-Leonesa and Castellano-Maestrazgo-Manchega botanical provinces, and only the Mesomediterranean bioclimatic level is present. The climax vegetation consists of Holm oak and Lusitanian oak (*Quercus faginea*) woods, as well as Mediterranean shrubs, although it is very disturbed by land uses, mainly agriculture and urbanism.

Results and discussion

Figure 2 shows species richness in each square, that ranges from 10 to 102 species. The north of the province has the highest species richness per square. In this area two very rich zones can be distinguished: One on the center and the other on the northeast end (Viejo, Martín & de Silva 1988). Another relatively rich region appears on the southeast, with 60-75 species squares. The mid-province region is rather poor, coinciding with the metropolitan area of Madrid. The highly cultivated Tagus Valley, at the south end of the province, is the poorest region. Comparison between the species richness and climax vegetation maps (fig.1) shows that highest species numbers correspond, to a large extent, with the Pyrenean Oak (*Q.pyrenaica*) and Lusitanian Oak (*Q. faginea*) climax areas, at the north and at the southeast regions respectively.

Figure 3 shows Average Chorological Index of every square, which varies from 5.5 to 7.5. The distribution of this variable is different than that of the former (Species Richness). The highest values correspond to the Mesas del Sureste (southeast Plateaux), climax domain of the Lusitanian Oak, although there are also some high ones on the central and southern areas of the province. Lowest values appear on the most altered areas (furthest south end) and on the Sierra de Guadarrama.

There is an interesting point to comment: Richest squares are not necessarily those with highest Average Chorological Index (correlation between both variables, r= 0.06). This is because of the own landscape nature and, consequently, because of the different lepidopteran species that occur in them. The north of the province is mainly cool and humid, and its vegetation corresponds to the phytosociological series of the Pyrenean Oak and Scottish Pine, and these vegetal formations are much closer (as a floristic whole) to those mideuropean-atlantic, than the Holm

Oak, Lusitanian Oak and Kermes Oak woods of the south of the province are, which is a highly Mediterranean area. In other words, there are more species with low chorological index in the northern Mountains than in the southern Plains, given that the environmental conditions on the Sierra de Guadarrama (mainly climate and vegetation) are very close to those on west and Central Europe. On the other hand, endemic species and biogeographically "rare" species (high chorological index) occur in typically Mediterranean biotopes (Baz, 1991).

Note that even farming lands, at least those of non irrigated croplands (olive groves, vineyards or cereal fields), present high Average Chorological Index; that means, many biogeographically interesting species can be found here, even if species richness is not high at all (Viejo, 1985).

Conclusions

Obviously the lepidopterologically interesting areas selection, pointing towards their protection, must be based on deeper studies than just the analysis of the species range UTM maps. But it is also evident that in the meanwhile these maps are the only useful argument to establish possible protected zones. Nevertheless, we consider that species richness is a limited criterion, because if we apply no other criterion, no attention will be paid to areas with a low species richness, but may be sheltering a biogeographically interesting fauna; that means the south of Madrid in the present case. By these reasons, we believe absolutely necessary to deep in the analysis, and applying other criteria as well, such as the biogeographic interest of the fauna (Idle, 1986), easily provided by the UTM maps.

Finally, we want to point out the interest that a rather mideuropean fauna has, inside a tipically Mediterranean environment, feature that increases the peculiarity of Sierra de Guadarrama fauna, at least from an Iberian perspective.

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